SUSTAINABLE DEVELOPMENT IN THE INDIAN CONSTRUCTION SECTOR THROUGH GREEN SUPPLY CHAIN MANAGEMENT

Synopsis

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1. INTRODUCTION

Green supply chain management seems to be the introduction of external factors, such as product production, purchase orders, etc. selection, into SCM production processes, distribution of the completed article to clients, and edge corporate development. As a consequence of a rise in competition & advertising demands as well as governmental pressures concerning environmental issues, firms have a tendency to implement environmentally friendly work practices. All dramatic breakthroughs are anticipated to be accompanied with obstacles or obstacles(Kant, 2015).

Environmental pollution & climate change has emerged as among of the main issues of both the twenty-first century, compelling governments and corporations alike to evaluate the environmental effects of their actions. Consequently, the necessity to green the building industry has become of essential importance. In the construction business, green supply chain management (GSCM) are viewed as an environmental innovation. In recent years, there has been a receptiveness between industrial practice with research on the topic for green supply chain management. With significant environmental impacts, the Indian construction sector requires environmental management reporting systems. Focusing on a literature examination of the environmental impact of Indian construction sector including green supply chain administration, this study was conducted.

1.1 Overview of the Indian Construction Industry

The building sector in India is an important indicator of both the country's economic success since it creates investment opportunities in a number of interdependent businesses. In 2011–12, the sector made an anticipated 670,778 crores (US$ 131 billion) to the nation's gross domestic product (GDP), contributing for around 8.2% of something like the total. The industry is fragmented, with such a number of big firms active in construction across all sectors, medium-sized businesses, and small businesses. sized companies specialized in specialist activities, including small and medium contractors that operate as subcontractors and do the work on the ground. India has little more than 500 constructions machinery manufacturing companies in 2011. The industry is labor-intensive that, including indirect employment, employs more than 49,500,000 people(Srivastav & Gaur, 2015).

It is anticipated that the building industry will play in adds to construction, a vital role in wealth creation structures that improve both productive capacities. There in 20th century, economist’s,

politicians and others regularly referred to economic progress as modernization. People have also used the phrases westernization &, especially, industrialization when describing economic growth. The environment is directly related to economic growth. Government efforts to achieve international socioeconomic objectives, such as stable prices, job growth, and sustainable development, consist of monetary & monetary and fiscal policy, finance industry trade legislation, including tax policies(Buyle et al., 2013).

In the last fifty years, India Construction have accounted for around forty percent of all development investment. 16 percent of something like the nation's working age population is supported by the construction industry. This construction industry in India employs over 30 million people and produces over 200 billion rupees of assets. Increasing reliance on private sector participation in building infrastructure via associated with early and methods such as build-operate-transfer is the primary cause (BOT). As a consequence, venture capital levels have not yet met projections.

1.2 Green Supply Chain Management

GSCM is the process of incorporating sustainability impacts integrated supply chain management, that comprises product development, material acquisition as well as selection, production, and ultimate distribution. product delivery, including end-of-life management consulting(Amade et al., 2020).

Approaches, Government subsidiaries, the dedication of senior executives, greater logistical management, smart personal finance, increased public knowledge of environmental concerns, including efficient waste management & re-use procedures are required for GSCM implementation.

Environmental considerations are included into supply-chain management (GSCM) (SCM). It comprises the design, purchase of raw materials, manufacture, distribution, or management of the final phases of a product's life cycle. Instead of concentrating just on lowering the environmental effect of the supply chain, GSCM entails supporting the development of value across all enterprises in the supply chain in order to minimize the overall environmental impact. GSCM's primary objective is just the decline of carbon dioxide emissions. Although it also offers so several tangible benefits to the organization, such as resource absorption rate, minimal waste production, process optimization,

decreased production costs, enhanced profitability, a repurpose of raw materials, a client's perception of value created, etc. On the premise both green building theory & supply chain management technology, GSCM also addresses the owner's or consumer's wants. Numerous designers, contractors, other suppliers are now working(Beldek et al., 2016).

Throughout the whole supply chain process, its goal is to ensure that the environmental impact of building goods is minimized and resource use is maximized, beginning with their design, material procurement, including construction, ultimately ending with their disposal. GSCM focuses on

- Cost reduction & maximization of economic gains
- Integration of sustainability practices in the external & inner administration of the business
- Low carbon emissions & environmental conservation

In GSCM, overall product movement was circular as well as irreversible, and all goods must be handled throughout their full life cycle, beyond which trash is repurposed and becoming raw material for further manufacturing or other uses. With green procurement, corporate environmental responsibility, including sustainability consumption knowledge & practices, green supply chains may be encouraged(Ali et al., 2020).

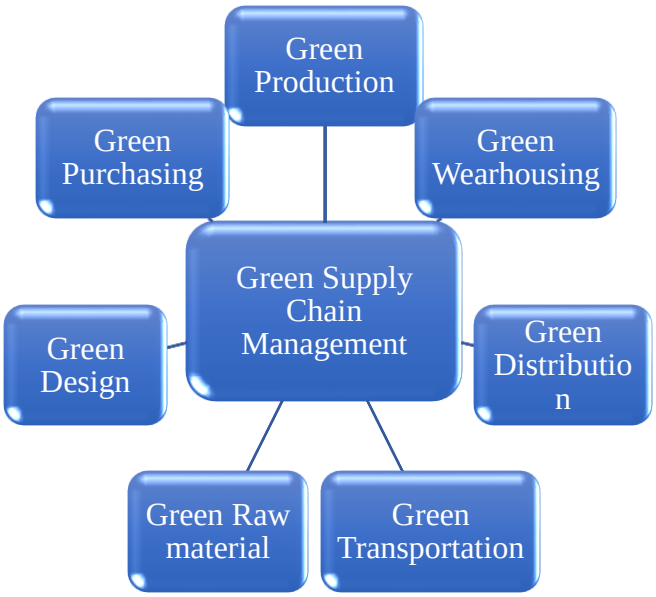

Fig.1.1. The Environmental Supply Chain Management

1.3 Green Supply Chain Management in Construction

In construction business, green supply chain administration (GSCA) is seen as an environmental breakthrough. The goal of GSCM is to have integrated environmental considerations into supply chain management. It also assists businesses in reducing carbon emissions, which have a positive effect on overall climate(Rao & Holt, 2005).

Because a supply chain could indeed reduce environmental pollution as well as production costs, as well as stimulate economic growth, start creating a competitive advantage in the shape of increased customer gratification, a positive image, and a positive reputation, and provide better opportunities to export their own products to environmentally conscious nations, it is advantageous for businesses to implement one(Broft & Koskela, 2018).

The attitude chosen by each party toward suppliers in its upstream or downstream supply chain is crucial to that success of GSCM. For the program to be successful, much more cooperation, openness, the convergence of supply chain procedures & technologies is necessary.

Controlling the supply chain requires knowledge of the separation & tracing of products & companies, businesses, logistics, people, activities, data, etc. assets that transform raw materials into a finished product that meets a specific need.

Buildings are becoming more complicated, demanding additional design involvement from specialist suppliers. Concurrently, the industry is becoming increasingly fragmented, as seen by the growth of specialized distributors, the proliferation of products, and also the dispersal of design and oversight activities.

Despite a very unpredictable supply chain, it construction sector has well-defined starting and end points development with construction are traditionally separated. Demand is seen as a succession of prototypes built via competitive bidding by transitory alliances. All of these factors have an effect on organizational connections(Badi & Murtagh, 2019).

Typically, informal/ad hoc & focused upon that project, not the company, project connections are short-term and have clearly defined beginning and end points. The relationships between competences vary with project. The consequent lack of consistency hinders innovation, process

optimization, and indeed the formation of more intricate connections. Additionally, the customer may influence the purchasing path and selection of important suppliers.

On big or intricate projects, responsibility & performance often cascade along the supplier chain to a multitude of providers, some of whom may be nameless at the chain's top. First and second tiers of a distribution chain may sign quite onerous contracts, but as the chain progresses, so do the contractual obligations, to the point where energy suppliers at the conclusion of the chain is often not tied in at all.

Transforming the viewpoint from 'project delivery' to 'project delivery' needs the development of (formal and informal) long-term connections, partnership, and alliance.

Companies that provide continuation in construction have been more interested in creating partnerships with suppliers beyond the top layer. This method was pioneered by frameworks contracts and collaborations, which stimulate the involvement of vendors in the earliest stages of a project and guarantee work continuity. This has led to an increase cooperation between leader designers and product designers, to everyone's benefit(Srivastav & Gaur, 2015).

Its Government Construction Strategy advocated three procurement channels to enhance the SCM process: private financing initiative (PFI), prime contracting, but also construction management. The customer gets onto a relationship with the tightly unified supply team, which may consist of the general contractor, designers, subcontractors, suppliers, and more.

1.4 Barriers/Challenges of Green Supply Chain Management in Construction

External and internal barriers are the challenges and obstacles to GSCM in the construction industry. Internal hurdles include financial constraints, a changing perspective, and cultural views. Cost of attempting to establish a green supply chain within this company, level of loyalty from leadership and highest level line managers in guiding the company in a new direction, absence of mineral income (ranging from technical understanding, techniques, green information, and process), complete absence of knowledge and experience, as well as utter lack of control necessity of pollution reduction policies, do seem to be impediments, among others. to green supply chain implementation(Amade et al., 2020).

In contrast hand, external barriers include, among others, a lack of green suppliers as well as products, a lack of government regulations and then a support structure, a lack of public awareness but instead demand, sponsors who appear difficult to implement technological innovations, marketable stress and market volatility, a lack of collaboration but instead cooperation between all of wide and varied supply chain stakeholders, as well as then a lack of ecological restrictions and monitoring plans. Below is a list of significant GSCM construction industry challenges:

Lack of government regulations and support system: Government may operate as both a Since it is tasked with establishing environmental laws for its building sector, but businesses are not required to participate in green practices in the absence of such legislation; the lack of state finance mechanisms remains the major obstacle barrier to GSCM practices in the construction industry.

Lack of knowledge and experience: Lack of understanding about GSCM is viewed as one of the major obstacles here to effective implementation of GSCM, given that it is impossible to participate in something that one does not understand and is thus too complicated to comprehend. Lack in knowledge & experience was identified as the most significant impediment to GSCM deployment there in Indian construction sector, and it was emphasized that the whole construction industry must be educated and mobilized(Amade et al., 2020).

The cost of implementing green supply chain: The significant cost of initiating GSCM and associated operations, like as product design, inventory reduction and selection, manufacturing procedures, distribution of the finished item to end-users, including recycling after the product's useful life, discourages firms from implementing a green supply chain. In a similar vein, Processes such like "direct but also transaction cost" are discussed, along with the possibility both of expenses constituting significant barriers toward the productive implementation of GSCM, and thus the complexity between reducing the ecological effect of business activities but also increase economic costs.

Lack of top management support in steering the organization in a new direction: Due of GSCM's strong driving force & capacity to ensure conformity, a shortage of commitment from higher management is a challenge. Coupled with its obligation to encourage, empower, and develop staff

engagement and commitment, which may be done via employee motivation, training & retraining, including efficient communications at all organizational levels(Amade et al., 2020).

Technology (lack of resources): Absence of eco-building supplies, absence of technical expertise, ongoing talent shortages, & labor shortages, amongst others, are seen as technical impediments that significantly limit the effective application of sustainable building principles.

Mindset and cultural belief: Incorporating adaptive reuse, green buildings, including environmental management principles into the day-to-day choice process of supplier relationships is another strong barrier toward the construction industry's adoption of GSCM. In order to address the aforementioned limitations, supply chain managers including logisticians must adopt a new mentality, and GSCM concerns that have been taken for granted by industry leaders and employees must be reevaluated. Building in India prefers the use of blocks but also reinforced concrete, also known as wet building projects. Ignorance of those As housing complexes may be developed with minimal environmental impact without funders' or developers' permission for GSCM principles, some styles of building practiced in other universes and consultants' lack of sustainability aims are considered as a significant hurdle(Amade et al., 2020).

Uncertainty: Examining the examined literature raises questions about a range of variables, including government actions and choices, consumer behavior and needs, as well as substantial advantage Organizations see uncertainties as a scenario that may or may not occur, thus they are urged to make advantage of it by recognizing, marketing, then communicating various business concerns faced there, also well as establishing new paths that may be necessary followed integrated in to the environmentally friendly software’s as good policy measures.

Green Practices in Construction: Green building is this same procedure of creating buildings and to use methods that are ecologically sustainable or energy all over a building's entire life cycle, from design through design, build, operations, repair, renovation, as well as dismantling.

These really are strategies used by businesses to reduce the negative environmental implications of their activity. The major objective is to identify the green practices relevant to every supply chain member(Qi et al., 2010).

Green design

Green design is considered as perhaps the most crucial stage since decisions made during such a phase have a major impact on the device's environmental impact during its lifespan. (Perotti et al., 2012)The notion of green design lowers the environmental impact of designing buildings, building operations. The objective of green design was to produce environmentally sustainable building projects.

Green Materials Management

Green material Management pertains to the replacement of hazardous products, actions or substances with those that are less harmful to the environment. It consists of two processes: green materials acquisition and selection. The primary Key criteria for choosing items that can be managed in green commodities administrations have included fact that the substances used in building must be easy to separate, adaptable, or advantageous for accelerating present operations. operations(Benachio et al., 2019).

Green transportation

Green transportation is characterized by actions performed to reduce environment consequences. Typically, construction projects entail a substantial quantity of transport operations, including both labor & material movement. Approximately 6-8 percent of a building project's carbon emission are created either by materials that are transported. To reduce emissions, transportation measures Include usage of full thousands of tons and fuel-efficient vehicles(Ali et al., 2020).

Green Construction

In addition to assuring environment preservation, green building aims to maximize the preservation of resources and minimize construction works that have detrimental effects on its environment, all while generating savings even inside the four systems for managing of land, water, energy, plus materials. Impact in terms use, waste, and emissions are essential parts of green construction.

Green Operation and Maintenance

In line with environment requirements, the green operations & repair program includes training, clearance, operational application, including management of green materials inside the projects(Akdag & Beldek, 2017).

Reverse Logistics

This process involves initiating, planning, executing, managing Reverse Logistics, building materials and product flows. It involves recycling, reusing, and then remanufacturing. Extract more Recycling key benefits include reduced energy use, air and water contamination, and usage of basic resources(Kaur et al., 2019).

Benefits of Green Building Practices

Economic

- Decreased costs for land preparation, construction materials, and operating expenses as a result of sustainable design
- Increased market value for properties
- Water conservation measures that minimize yearly water & municipal wastewater expenditures
- Expanded regional economic development possibilities
- Improved energy efficiency techniques resulting in decreased peak power requirement, reduced need for additional energy infrastructure, reduced energy prices for customers, and up to a 70% reduction in yearly fuel & electricity expenditures(Perotti et al., 2012).
- Structures and machinery with longer lifespans due to intelligent launching methods

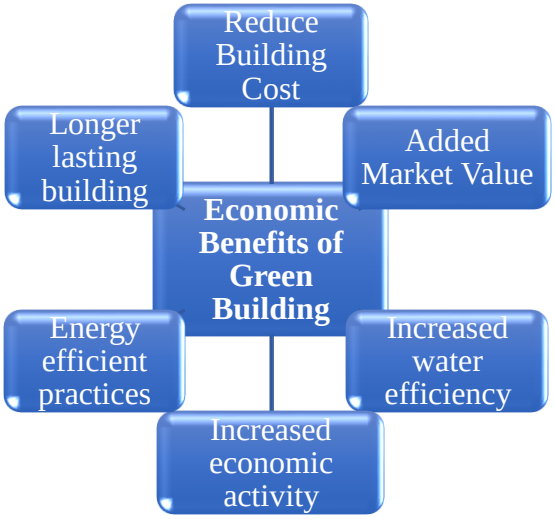

Fig.1.2. Economic Benefits of Green Building

Social

- Accessibility to infrastructural services, including such transit, on an equal basis
- Less wastewater processing facilities and improved water resource protection activities
- Reduced number of new gas turbines & distribution lines in the neighbourhood
- Expansion of the marketplace of ecologically desirable items
- Enhancement of occupant happiness, comfort, & individual output(Benachio et al., 2019).

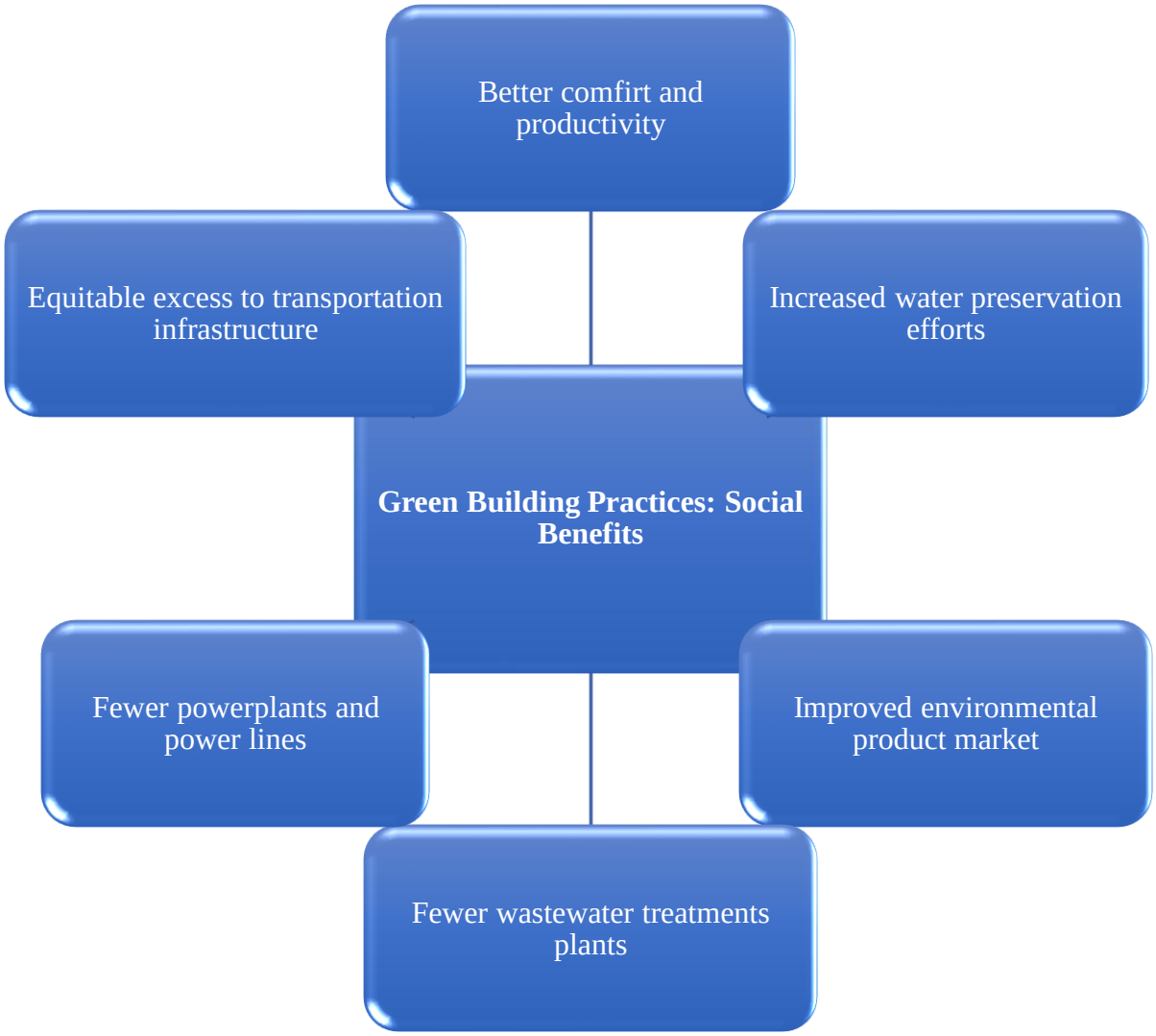
Better comfirt and productivity
Equitable excess to transportation infrastructure
Increased water preservation efforts
Green Building Practices: Social Benefits
Fewer powerplants and power lines
Improved environmental product market
Fewer wastewater treatments plants

Fig.1.3. Social Benefits of Green Building

Environmental

- Enhanced property preservation, decreased resource & energy use, and conservation of natural assets.

- Conservation of water supplies for agriculture & animals(Awasthi et al., 2010).
- Less power & fossil fuel use, as well as less negative effects from fossil fuel manufacturing.
- Increased indoor air quality &, thus, decreased pollution levels.

1.5 Waste Management in Green Supply Chain Management

Multiple phases of the production process might be related with waste creation, ranging from the method used to manufacture raw materials through the garbage generated by end users/customers. Additionally, buildings may cut waste in their daily operations. This comprises tenants and operators collecting, sorting, & recycling garbage. Additionally, building owners may decrease waste on a broader scale by recycling demolition waste to lessen the quantity of garbage that ends up in landfills(Shi et al., 2012).

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Multiple phases of the supply chain might be related with waste creation, ranging from the method used to manufacture raw materials through the Garbage created by consumers or end users. Without losing in the sake of generality, here present a cradle-to-grave (C2G) paradigm for measuring waste production based on the stylized four-stage distribution process shown in Figure. At Stage 1, a number of companies was engaged in the production of raw materials, which are also used in Stage 2 subsequently used as inputs by organizations at Stage 2 which prime objective is production and manufacturing. Transportation & logistics activities are the focus of businesses in Stage 3 (and get feedback from Stage 2) that service the end clients (and receive input from Stage 2). (Stage 4)(Mahajan & Vakharia, 2016).

Relating per each level of the stylized distribution chain shown in Figure, our suggested framework identifies the effect of the 3Rs on businesses across each phase of both the supply chain from a Reduce viewpoint, companies at all levels of supply chain may require to investigate product improvements to create fewer waste (through designs for the environment programs, for instance) and/or concentrate on bringing more ecofriendly components into the execution activities. In fact,

under Used & Recycle plan, each inputs to a supply chain step should result in the accumulation of components, which are subsequently processed and supplied back to the relevant supply chain steps.

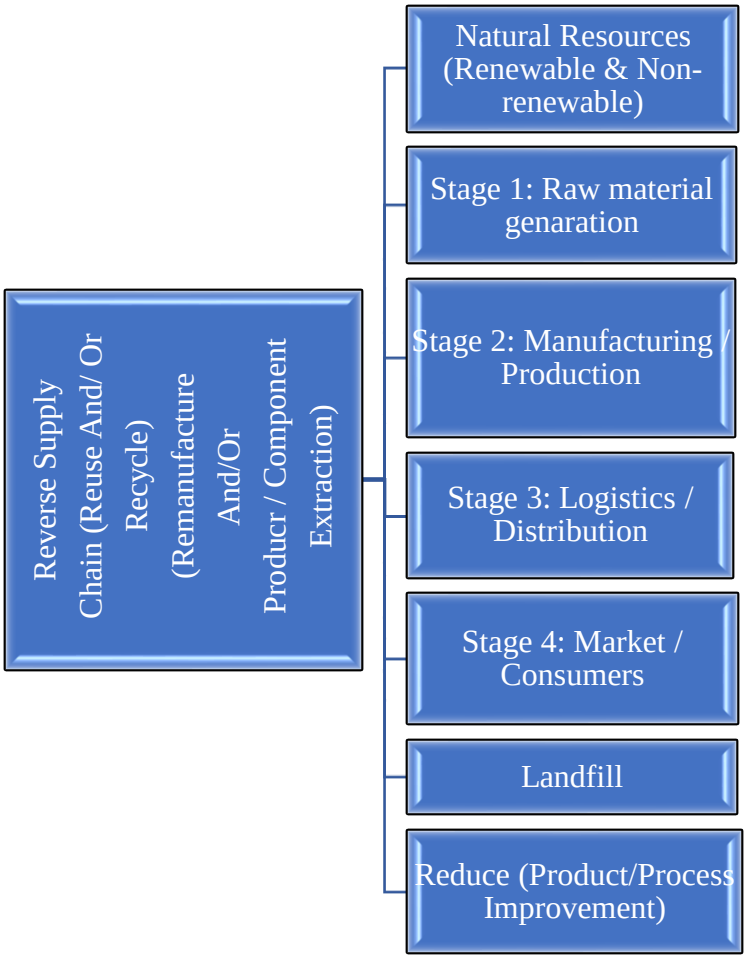
Reverse Supply Chain (Reuse And/ Or Recycle) (Remanufacture And/Or Producr / Component Extraction)
Natural Resources (Renewable & Non-renewable)
Stage 1: Raw material genaration
Stage 2: Manufacturing / Production
Stage 3: Logistics / Distribution
Stage 4: Market / Consumers
Landfill
Reduce (Product/Process Improvement)

Fig.1.4. Supply Chain and Waste Management

Depending on this paradigm, it is evident that enterprises within the supply chain may choose either a proactive strategy (related with Reduce) or perhaps a reactive one (related to Reuse and/or Recycle) for the efficient control of garbage out across supply chain. By putting both new as remanufactured items on the market, for instance, and by gaining profits from recycling activities, the reactive strategy that focuses on prolonging product life may provide positive externalities for particular businesses. In terms of reuse and/or recycling, an increasing number of manufacturers and suppliers find reverse supply chains viable. Firms are seizing on the chance to provide remanufactured items alongside new products, reusing salvageable components and recycling remaining hardware for sale to restrict waste production (the proactive approach), administrations might have to enforce legal requirements. This is principally due to the fact that businesses are primarily driven by selfish

motives via price signals; hence, all aggressive effort likely lead to negative effects on society. As a consequence, governments have developed environmental legislation policies that seek to internalize these detrimental impacts.

A current strategy for reducing trash output is the imposition of laws. In general, all laws in this field may be categorized as either Pigouvian or Caucasian ancestry. The Pigouvian technique collects taxes to cover for profit margin of aggregate rubbish collection, while the Coasian method distributes ownership rights with in environment of disposal by charging businesses based on the quantity of waste they generate(Mahajan & Vakharia, 2016).

This research will use the following instruments to examine how a for-profit firm might maximize waste management by employing GSCM:

Cost-Benefit Analysis: Its cost-benefit analysis assesses all consequences in monetary terms, while environmental costs must be quantified in monetary terms and incorporate the cost of averting a negative effect, such as via pollution management.

Life Cycle Assessment: The life cycle assessment (LCA) model takes into account all possible environmental consequences during the lifecycle of a product, from raw material to ultimate disposal. In order to gain a better appreciation of the whole manufactured product, production is examined(Buyle et al., 2013).

Multi-Criteria Decision Analysis: Its multi-criteria decisions analysis (MCDA) concurrently finds many criteria and options. Unlike the cost-benefit model, which only considers a two dimensional objective function, the MCDA method analyzes many, sometimes competing criteria simultaneously, resulting in a robust analysis(Study et al., 2018).

Diverse sorts of companies have to use different tactics, and a for-profit business and just a non-profit organization are most likely to employ distinct techniques. Therefore, it is said that these analytical techniques by themselves are not an sustainable method, given that each has weaknesses that need additional investigation before they can be employed independently. Therefore, these three analytical techniques will be used concurrently in the study. The three techniques may provide diverse

viewpoints on management of waste in for-profit firms and may be utilized in this research to develop a waste management plan for a commercial company.

Guidelines for Waste Management Practice

It should be mentioned that waste management organizations are expanding worldwide or that excellent waste management techniques are prevalent (e.g., programs for electronic waste in China, plastic packaging in Tunisia, and various material flows in Brazil). Others would be administered by other companies or governments.

First, in fact for a waste management strategy to be effective, recyclers like remanufacturers must have been ready to spend substantial money in commodities sectors with razor-thin margins in order to build the necessary skills. This is due to the fact that enterprises in just this sector must not only have access to sufficient quantities and grades of used products, but also enter into long-term contracts to do so. This is essential to their ability to plan + invest in successful product flows. As indicated before, it may be advantageous to do more study on the proper control and management for the waste management step of the retrograde supply cycle in particular to resolve the issue(Poon et al., 2004).

Second, companies involved in waste management may actually encourage and maybe invest in innovative processing processes while building recycling as well as reuse programs. In addition, firms must enter into long-term agreements with waste providers in order to obtain adequate quantities for their operations. Therefore state should concentrate on mitigating this similar financial risk for enterprises involved in waste management operations, either by explicit financial help or by requiring that trash makers use the skills of reusing and recycling firms(Udawatta et al., 2015).

When creating and implementing rewards program for something like a waste management firm, complete operational openness must be maintained. This would create a credible framework as in eyes of the sludge treatment specific vendor (i.e. garbage providers) also make it easier to for state to monitor the company's conduct. Such transparency would also play a crucial role in generating a process of constant improvement throughout the pretty much the entire reverse supply chain, so permitting improvements to the collection & treatment techniques beyond regulatory guidelines.

Thirdly, government & management must provide massive support to waste management methods. Extensive empirical research demonstrates that the waste management business has been seen as a component of the informal economy; hence, it is likely to be viewed as susceptible to segmentation, opportunistic actions, mismanagement, or non-professional management. Given the importance of the three R's in waste management, the current organization must be modified to reflect enhanced performance leadership by individuals with leadership, analytic, and strategic perspectives.

Lastly, there is an urgent need to combine and concentrate existing academic research to the most essential areas for effective waste management. Instead than focusing on a "one-size-fits-all" strategy & set of recommendations, industry- & problem-specific research should indeed be prioritized. Creating a justification for re-manufacturing, for instance, is undeniably vital, however there is a dearth of research investigating the viability of that kind of option for diverse products and processes across industrial groups. Instead of focusing just on EPR-type processes advised for e-waste, it is vital to investigate and examine various types of environmental legislation for effective waste management(Mahajan & Vakharia, 2016).

Ways to Reduce Waste in Green Supply Chain Management

- Designing for Material Optimization.

Decrease the number of materials inside the building's structure and the amount of trash generated during construction. Design materials & components for disassembly there at end of their lifespan(Poon et al., 2004).

- Material Selection.

Support a recycling industry by recycling items and components or specifying recycled-content items.

- Waste Management Planning On-Site.

Assure that building site practices promote garbage separation and recycling. Planning for decreased C&D waste must occur at the beginning of a project as part of any integrated strategy(Poon et al., 2004).

- Pre-Design Phases.

- ✓ Establish waste reduction objectives and determine if design of deconstruct & adaptability principles may be implemented.
- ✓ Conduct an inspection of any extant site to see whether recovery of building parts or adaptive repurposing of the buildings is viable.
- ✓ Programming: Can capacity be reduced by using items more efficiently?
- ✓ Methods: Can BIM design include significant data with integrated life-cycle analysis?

- Schematic Design.

Retain a collaborative session for content optimization but also waste reduction solutions during the schematic design phase. Contemplate off-site construction of building modules and elements(Love et al., 2004).

- Program to Make the Most Use of an Asset.

1.6 How Green Supply Chain Management Can Help Firms with Building Brand Image

While developing a marketing plan, we neglect the influence our supply chain might have on the narrative we convey. Stories & marketing strategies are built dependent on the product's quality, manufacturing process, and charity contributions associated with the product, among other aspects. A supply chain becomes only a mechanism of manufacturing and distributing a product to the client. However, attempts to adopt green initiatives throughout your supply chain may assist improve your brand's image & footprint as indicate to stakeholders you are attentive to every tiniest business aspects (Taghavi et al., 2021).

Positive Impact on the Brand

Employing sustainable efforts across the boards has shown to favorably position the business in the eyes of consumers and boost sales. Additionally, sustainability activities enable the business to convey more emotionally-driven tales. This contributes to the creation of better content material information in a world where the emphasis on the quality & amount of content a firm can provide(Balasubramanian & Shukla, 2017).

Green Supply Chain Initiatives You Can Implement

By converting the majority of logistical documents & paperwork to electronic format, the organization will demonstrate its commitment to environmental sustainability throughout its supply chain with correct technologies and procedures, going paperless would also increase staff productivity overall logistics. It creates a win-win scenario for all parties concerned.

However, keeping in mind that deploying new procedures and technologies is often easier said the done. You may encounter persons who have difficulty adapting or who just refuse to change. It is essential to shift gradually and to provide enough training and direction to support the transition strategy. After this same transition has occurred, it is crucial to implement the new procedures. Catalyst is equipped with the necessary technology and continuous assistance to facilitate the organization's transformation.

Recycling Your Pallets: The majority of logistic & supply chain experts concentrate on two characteristics of a pallet: dependability (quality and availability) & cost. Frequently, the effect a pallet may have on any brand is neglected(Benachio et al., 2019).

Companies such as Kamp's Pallets provide an extensive array various pallet recycling, repair, & buy-back services. Participating in these initiatives enables the organization to have a direct effect on the amount of pallets rescued from landfills, the numbers of trees that must be chopped down, as the tons of CO2 emitted during the process(Radhi, 2008).

Upgrades in Technology for the Fleet: The most recent fleet management solutions and software may assist your corporation in enhancing a variety of environmental elements. Software for fleet management helps prevent bad driver behaviours such as speeding, idling, etc. aggressive driving. It may also assist your drivers get at their location faster. All of these enhancements minimize gasoline usage, fuel expenses, and greenhouse gas emissions(Devi & Palaniappan, 2017).

It is essential to keep in mind that now the positive impacts of sustainable efforts may not instantly appear on the brand or the company. Dependent in the sector, the shift in customer behaviour and viewpoint might be a time-consuming process. Although these projects need time, but are a wonderful invest in the company's and its planet's future.

1.7 Sustainable Construction Technologies Used in Green Construction

Green construction can be used interchangeably with green building or sustainable construction. Therefore, green construction means the use of resource-efficient and environmentally responsible processes in construction to ensure the lifetime sustainability of the building.

Primarily, the sustainability context of the building implies building operations, site design, maintenance, repair, and demolition with the least harm on the environment. The process requires close collaboration of the construction engineers, the client, and the architects in the entire construction project.

The aim is to ensure the building and construction methods are cost-effective, durable, and reduce the overall effects on the environment and human health with a central focus on efficient use of energy and resources, water preservation, improved occupational health, and reducing pollution and wastage.

Any building or any type of structure can be a structure of green construction, better called green building.

Characteristics such as unique cultures & traditions, typical climatic conditions, diverse building types, or a wide range of social, environmental, and economic priorities tend to vary in countries and/or regions. All these fix their approach to green building.

Usually, these include efficient use of energy specifically renewable energy, such as solar energy, water, and other resources, pollution and waste reduction measures, enabling of re-use and recycling, good environmental air quality indoor, use of non-toxic and sustainable materials, the environment-friendly design, construction and operation design that allows adaptation to a changing environment and most important consideration of the quality of life of occupants.

1. Solar Power

Solar power has been increasingly exploited as sustainable construction technology. In green construction, it can be utilized in two ways, one pertains to active solar energy and another is passive solar power.

2. Biodegradable Materials

The use of biodegradable materials is an eco-friendly means of making construction sustainable. Most traditional construction materials lead to the accumulation of waste products and toxic chemicals, the majority of which take hundreds of years to break down. And even after they degrade, they contaminate and harm the environment.

3. Green Insulation

Insulation is one of the greatest concerns when it comes to the construction of buildings and homes. However, most people hardly know that insulators are simply wall filters that don't need to be made from expensive and highly finished materials.

4. The Use of Smart Appliances

Homes and commercial buildings consume the world's most energy. This is why it has necessitated the use of smart appliances as part of sustainable construction technologies. The durable construction technologies emphasize on the installation of energy-saving and efficient appliances.

2. LITERATURE REVIEW

2.1. Literature Map

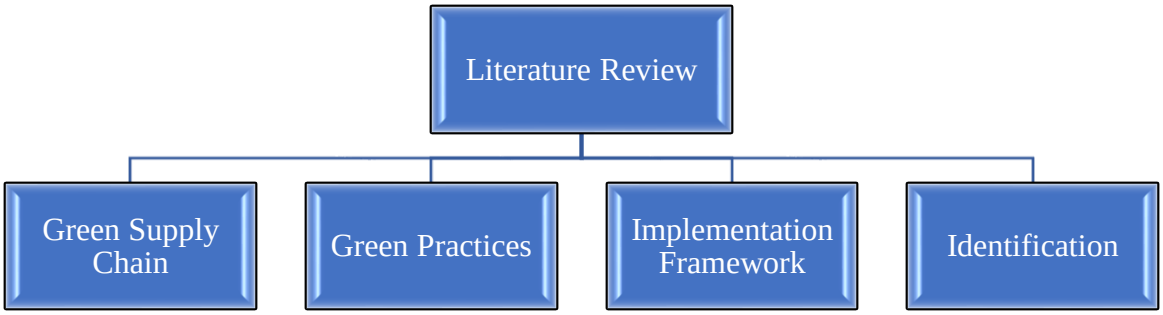

Fig.2.1. Literature Map

2.2. Conceptual Coverage of Literature

These section will undertake a systematic literature and examine the scope of GSCM implementation in the construction industry. This assessment will consist of peer-reviewed articles and conference papers published during the last 10 years discussing the use of GSCM approaches in the construction

sector. The outcomes of the research will be divided into four major categories: supply chain links, marketplace competitiveness, life cycle, & waste management. To achieve more durable results, these strategies should be employed across the whole structure life cycle, notably as in design phase, throughout the components selection process, according to the most significant findings of the current research. The efficiency of government subsidies to stimulate the deployment of GSCM will also be investigated(Shi et al., 2012).

2.3. Classification of Literature Review

The following is a general categorization of the preceding papers:

1. The emphasis of the article is comprised on the following:

- Concept of green supply chain management
- GSCM Adoption in the Construction Sector
- Best Practices
- Value Chain Analysis
- Implementation Framework
- Bottleneck Identification

2. Context of the Paper

- Indian
- Foreign(Mahajan & Vakharia, 2016)

3. Type of data for analysis

- Quantitative
- Qualitative

4. Research Design

- Exploratory
- Analytical
- Descriptive(Devi & Palaniappan, 2017)

Table.2.1. Reviews of Literatures

Author	Year	Methodology	Concept	Approach
Abidin, N. Z.	2010	Literature review with case study	Investigating the awareness and sustainable construction	
Bai, C., & Sarkis, J.	2010	Literature review	Integrating sustainability into supplier selection	Grey system and rough set methodologies
Green, K. W., Zelbst, P. J., Meacham, J., & Bhadauria	2012	Literature review and case study	Improved environmental performance and economic performance	GSCM practices and performance model
Perotti, S., Zorzini, M., Cagno, E., & Micheli, G. J	2012	Literature Review	Specific practices implemented and level of adoption	Multi-case study research
Dues, Tan and Lim	2013	Literature review with case study	CO2 emissions, waste reduction, green practices	Intersecting lean as well as green paradigms.
Laosirihongthong, Adebanjo and Tan	2013	Literature review with hypothesis testing	Proactive and reactive practices, business strategy	Study of factors and multivariate linear analysis
Ahi and Searcy	2014	Literature review	Composite environmental metric system	Theoretical foundation for environmental performance management
Ortas, Moneva and Alvares	2014	Research paper with hypotheses testing, empirical analysis	Corporate Social Responsibility, interaction between (SSCP) and firm's Financial Performance(FP)	Econometric models
Mitra and Datta	2014	Literature review, survey and hypotheses testing	Supplier collaboration for environmental sustainability, economic performance	Managerial implications for the government and companies
Tachizawa *et al.*	2015	Literature Review, Case study with empirical analysis	GSCM drivers, approaches and performance	Collaborative GSCM practices
Govindan, K., Rajendran, S., Sarkis, J., & Murugesan, P.	2015	Literature review	Supplier evaluation that considers environmental factors	Multi criteria decision making
Luthra, S., Garg, D., & Haleem, A.	2015	Software model, case study and numerical analysis	Achieving sustainability in Indian automobile industry	GSCM practices implementation

Malviya, R. K., & Kant, R.	2015	Literature Review, Case study with empirical analysis	Model building and testing	Review and classification Process
Tao, F.,	2016	electricity-attention (GMS-EC) in product layout	Compared with genetic algorithm (GA), group chief set of rules (GLA) and artificial bee colony setoff rules (ABCA)	Hybrid optimizing approach named chaos quantum institution leader algorithm (CQGLA)
Balasubramanian, S., & Shukla, V.	2017	Literature review, survey and hypotheses testing	Improving the efficiency and effectiveness	
Akdağ, H. C., & Beldek, T.	2017	Case study with empirical analysis	Construction waste management, green building design, green building operations	GSCM
K. Mathiyazhagan	2017	literature survey of various multi criteria decision making (MCDM) method, AHP for ranking of drivers of GSCM	identifying and prioritizing the important drivers for the implementation of GSCM with the help the Analytic Hierarchy Process (AHP)	benchmark the critical drivers for GSCM implementation by deleting unnecessary drivers.
Al-Ma'aitah, N.	2018	Research paper with hypotheses testing, empirical analysis	Construction, GSCM, Jordan, Performance.	Green supply chain management (GSCM) practices
Jasneet Kaur	2018	Literature review, each matrix using direct rating from experts and Pareto analysis.	identifying the 'critical' or 'vital' barriers across the green supply chain field.	Barriers in Green supply chain management (GSCM)
Mochamad Agung Wibowo	2018	Literature review, model and the Delphi method	elaborating the concepts, dimension and elements of GSCM	framework for Green supply chain management (GSCM)
Rafaella D. Broft	2018	Literature review	Construction from a production perspective	Aspects of the F- and V-conceptualizations of the production theory that are crucial
G L F Benachio	2019	systematic literature review	creating a more sustainable supply chain, given its uniqueness.	implementation of GSCM practices and concepts

Yousaf Ali	2019	Literature review and multi-criteria decision making (MCDM)	pointing out that a GSCM framework needs to be used in the CPEC projects to lessen the negative impacts	Green supply chain management (GSCM) practices
Yichuan Deng	2019	Integrated 4D BIM-GIS Framework for CSCM	4D BIM and GIS integrated framework to improve CSCM between construction sites and other project-related organizations.	Construction Supply Chain Management (CSCM) and BIM-GIS framework
D. BARANIKUMAR	2021	Literature review, one sample t test	contribution of each component to green supply management in the construction sector	conceptual framework of Green supply chain management activities
Erfan Taghavi	2021	literature review and discussing with university professors and industry experts	Identifying and evaluating the weight of actuators to implement GSCM	Green supply chain management (GSCM) model
Fuat Kosanoglu	2021	Literature review, utilizing the analytic network process	ANP model and analysis	sustainable supply chain management, Dimensions of SSCM and SSCM in the Construction Industry
Maria Ghufran	2021	Literature review, system dynamics model	The system dynamics (SD) methodology employs modelling and simulation tools	Sustainable supply chain management (SSCM) and development of a causal loop diagram (CLD)

3. RESEARCH GAP

It is believed that the building sector is probably one of the largest garbage generators in the world. The concept of environment sustainability throughout a construction industry may be implemented in several ways to address this issue, such as by decreasing waste, cutting carbon emissions, selecting better materials, etc.

As a result of environmental issues and the expansion of the construction sector, a new subject has emerged: utilizing green supply chain management (GSCM) to manage construction waste. To ensure

that this is successful, the design team, architects, engineers, & client must collaborate closely at every step of the project. GSCM reduces energy consumption and trash, hence it does not pose significant health or environmental risks.

This literature analysis revealed that there is a dearth of information on material waste there in construction sector. Few real-world research have been conducted in many nations, because with the exceptions of Skoyles' 1976 research, they have all focused on a limited number of materials at a few of building sites.

In terms of implications for future research, this work fills a vacuum in the literature on the use of GSCM with in construction industry. Given that no other research have examined the systematic greening of the building industry in such depth, this study is unprecedented.

Overall, the construction industry lacks sufficient knowledge of fundamental & supporting green practices, as much as of the extent to which each stakeholder can implement them. This information may enable clinicians in determining the "what" & "how much" of adopting green practices, hence increasing the usage of green practices in business sector as a whole.

Several crucial drivers appear to also be absent. For instance, market pressure, which generally seen as a major factor for becoming green in other sectors, has not been studied extensively or at all in the building industry. Green buildings are expected to get a great deal of consumer pressure since they save a great deal of energy & water and to use no or fewer harmful chemicals, which is beneficial to your health.

To increase the adoption of green practices in the building industry in general including by different stakeholders, it is necessary to have a thorough grasp of the various performance metrics and how green practices modify or impact them. The information is currently unavailable.

Each stakeholder throughout the construction industry must understand the consequences of certain green practices (implementation) for environmental, cost/economic, and organisational performance. With for this knowledge, practitioners would be able to prioritize the implementation of green practices that help the business reach its green performance goals (taking all three performance aspects into consideration). It'd also aid firms in assessing which eco-friendly practices are not

operating as well as they should and in boosting their performance (in terms of efficiency and effectiveness of implementation). Unfortunately, none of the construction research has investigated the link between green practices and green performance.

This construction sector adopted the GSCM idea to enhance its environmental treatment for a number of compelling reasons. Acceptance drivers for GSCM are factors that motivate people to utilize it. Researchers have examined obstacles as well as pressures from India's perspective and analyzed them in depth. However, there is currently a dearth of studies evaluating why individuals utilize GSCM. No study has been conducted to determine why Indian construction industry have adopted GSCM.

It is evident from a study of the literature on the drivers of GSCM in international and Indian settings that adopting GSCM is crucial and has long-term advantages. However, the Indian construction sector struggles to identify the most compelling arguments for implementing GSCM. There is a great deal more potential of GSCM to somehow be adopted in in Indian construction sector, but it has not yet been implemented due to implementation issues and the absence of critical drivers for GSCM deployment. It might be useful to do study to determine and prioritize the most essential GSCM implementation drivers. As a growing nation, India has a great deal of potential in the construction business. However, they must be informed of the advantages of embracing GSCM.

4. NEED FOR STUDY

Within era of globalization, Green supply chain management (GSCM) is regarded as an effective technique for addressing a variety of environmental issues inside the global value chain. Integrating environmental framework into managing the supply chain is the principle behind GSCM. GSCM not only reduces environmental effect, but also reduces costs, increases productivity, and accelerates innovation. This research intends to examine the relevance of GSCM, as well as This Indian construction industry’s motivation as well as operational challenges. The framework facilitates the development of environmentally friendly, profit-generating concepts for enterprises.

In the current context, environmental issues but instead the consideration for sustainability were also trying to encourage various industries to take steps to make optimal use of assets such as electricity, water, as well as materials; to efficiently execute waste avoidance measures; and so design and

develop ecologically sustainable yet eco-friendly structures. The regulations play a significant role in guaranteeing the implementation of sustainable actions at the grassroots level. This leads in environmentally sustainable processes that continue to function without causing damage to the environment. Environmental dangers may be avoided at each phase of any supply chain, from the acquisition of raw materials through reuse, recycle, or disposal. Sustainability is essential for improving the quality of systems to produce a healthy ecosystem, including improved social, economic, as well as environmental conditions for future generations. This strategy strengthens the link of science and comprehension in the domain of reversed supply chain & how it may be used to control waste. All study on The idea that landfill waste might well be decreased by reusing, refitting, and recovering existing products/components encouraged the development of backward supply chains.

To fight this issue, the construction sector may employ environmentally friendly methods in a range of areas, include waste reduction, carbon reduction, and improved material selection. Consequently, the introduction with Green Supply Chain Management (GSCM) would aid the sustainability component of construction, since this scope of areas requires the collaboration of several stakeholders across the whole life lifecycle of its project. The concept of GSCM has been used in multiple companies in the past; nevertheless, each construction sector has unique difficulties that need a unique implementation strategy, taking into consideration industry-specific differences.

Usually, construction has severe and irreversible impact on the environment, including excessive resource usage, power consumption, pollution, and toxic waste.

Consequently, the notion of sustainable building is widely used in relation to the growing demand for environmental consciousness. Sustainable design should encompass not just the utility of a structure throughout its lifespan, and also the reuse of the materials after usage to reduce waste. Numerous investigations show shown that GSCM might have a significant influence on the environment while simultaneously raising enhancing product quality, increasing efficiency, and mitigating supply chain disruptions. Although the GSCM strategy's merits are easily evident, its execution is difficult. Concerns about global warming seem to be now of the highest urgency, while construction continues

to generate water, noise, as air pollution. By implementing GSCM, the majority of the construction enterprises may work in a sustainable way, for example, by choosing recyclable materials over ordinary ones. Also on basis of securing quality, safety, and many other basic requirements, concept of supervision and technological progress should be utilized in the construction industry to enhance the economic viability of materials and cut the building projects that has adverse environmental effects, as well as to develop the goal of five cash holdings (energy, land, water, but also materials) but rather environmental protection. Employing GSCM in the construction business would be beneficial. GSCM method to reduce construction waste.

5. CONCEPTUAL FRAMEWORK

Table.4.1. Construction Industry Stakeholders

Construction Industry Stakeholders	
Direct Stakeholders	**Indirect Stakeholders**
- Developer	- Local Authority
- Consultants	- Environmental Authority
- Supplier	- General Public
- Contractor	- Town
- Client	

The green supply chain management (GSCM) strategy for addressing pertinent issues may be analyzed in regard to the following factors:

- Implementation of green practices by stakeholders.
- Motivation of stakeholders to implement such techniques.
- Obstacles posed by stakeholders to the adoption of these practices.
- The consequences for performance as a whole

This spurred research to build & verify a multilayered GSCM framework for identical infrastructure spending that would include all the key supply chain stages, allow for the obligations of the numerous stakeholders, and recognise the relevance of the supply chain framework to exhaustively create the GSCM variables of the construction industry.

GSCM serves significant environmental performance-related reasons, including risk management, fulfilling market expectations, attaining strong business performance, and complying with legislation. In reaction to government environmental restrictions, sector businesses have started to integrate

GSCM implementation into customer requirements, which may result in ecologically friendly operations.

Every construction sector has adopted like an antidote to traditional practice, green supply chain management (GSCM) serves as a cure. By applying a life cycle approach to hardware design, materials, production, sales, and recovery, green supply chain management aims to optimize ecological profit.

Framework of green supply chain processes for implementation in the construction industry:

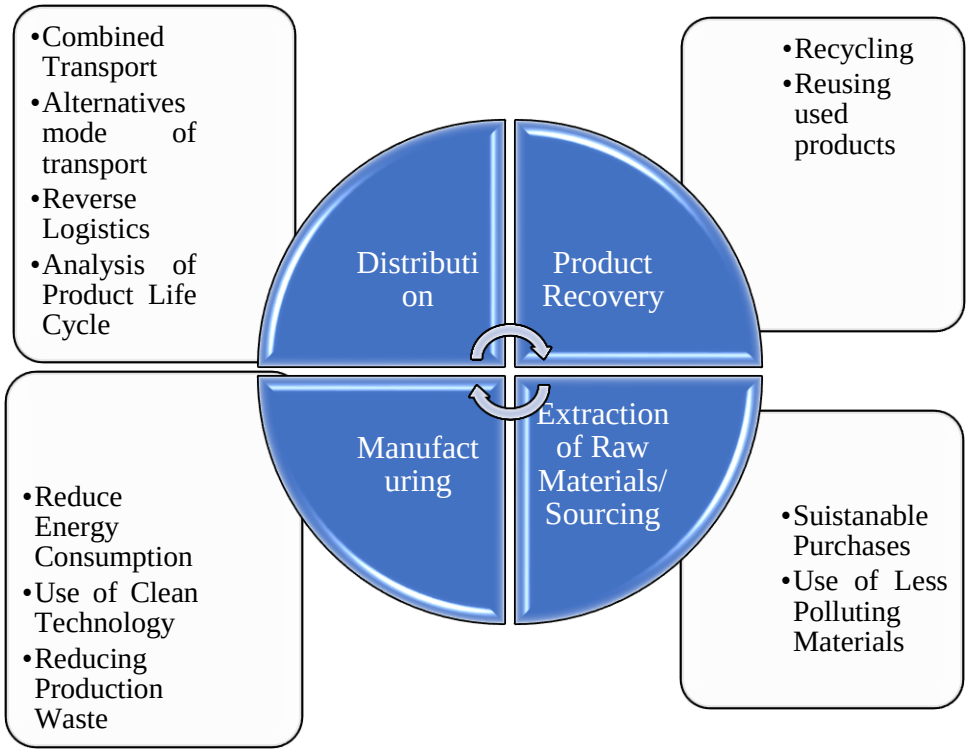

Fig.4.1. Green supply chain processes for implementation in the construction industry

6. OBJECTIVES AND HYPOTHESIS

This building business is among the most vital industries. GSCM aims to eliminate or reduce wastages. GSCM has emerged as a significant breakthrough that enables firms to adopt "win-win" strategies that accomplish profitability share goals while reducing environmental risks while effects and increasing ecological efficiency. Studies indicate that a vast majority of companies recognize the significance of GSCM, yet only a small fraction of enterprises actively implement these practices(Formoso et al., 2002).

6.1. Objectives

The purpose of the study is to discover variables such as:

Objective 1: To assess the status of green supply chain management application in Indian construction sectors.

Objective 2: To assess the obstacles/issues and difficulties of green supply chain management experienced by Indian construction firms.

Objective 3: To investigate the Green Supply Chain Management (GSCM) That Deal with Construction Waste and also its influence on the management in the development waste in Indian construction firms.

Objective 4: To study on Green Supply Chain Management in Indian construction industry in an effort to establish a brand or corporate image.

Objective 5: To examine how Green communication mediators the connection between organizational green activities and Brand/corporate perception.

Purpose: Study aims to gain a knowledge of the dimensions, as well as context of green supply chain management (GSCM), in addition to construction waste management and its expected impact following successful implementation, and thus to develop a framework for the adoption of GSCM in the construction industry.

Limitation: This practical component of the study, i.e., the application of all this model in building projects, will be not addressed, resulting in the omission of several aspects.

Practical implications: Overall findings of this study might provide fresh insights for managing development projects using the Green Supply Chain Method(Wibowo et al., 2018).

Social implications: To enhance the effectiveness of building projects, construction industry stakeholders must comprehend the ideas of development waste management consequences of Green Supply Chain.

Originality/value: The study will give the foundation for execution that will allow the building industry to achieve sustainable outcomes. It will establish an evaluation methodology for GSCM application performance metrics in infrastructure projects.(Rao & Holt, 2005)

6.2. Hypothesis

Supply Chain Relationship

Supply Chain Connections is the topic of study with the largest quantity of papers in this review; it focuses on the relationships that may occur at various levels within the supply chain. The majority of the research focused on the interaction between both the Construction Company or company supplier or indeed the contractors as well as subcontractor, attempting to determine how some relationships influence the usage of GSCM inside this construction sector. Corporations must include additional information concerning the environmental consequences of each commodity into their material procurement choices. In addition, environmental capabilities of manufacturers must be governed by higher and more uniform norms(Kosanoglu & Kus, 2021).

Therefore, we hypothesize:

H01: The building industry's supply chain relationships does not have beneficial influence on the ecological effects of sustainable development.

Ha1: The building industry's supply chain relationships have beneficial influence on the ecological effects of sustainable development.

Barriers/Issues and Challenges of Green Supply Chain Management

Barriers/Issues & Challenges is the field of study with the largest number of papers in this review; it relates to the management that may occur at various levels within the supply chain.

Green Supply Chain Management (GSCM) must have emerged as a critical organizational philosophy to reduce the negative environmental risks, yet there are numerous Barriers and Drivers that affect the directly and indirectly application of GSCM in such an organization (differing at different levels and according to the stage of the organization's growth(Wibowo et al., 2018).

H02: The barriers encountered by the Indian construction company during the implementation of Green Supply Chain Management does not have detrimental influence on the ecological effects of sustainable development.

Ha2: The barriers encountered by the Indian construction company during the implementation of Green Supply Chain Management have detrimental influence on the ecological effects of sustainable development.

Construction Waste Management

This European Union Council issued a waste management regulation in 2008 with the objective of decreasing construction sector waste creation by 70% by the year 2020. To further comprehend how a Green Supply Chain Management may assist a construction business in achieving this objective, research should be conducted on the inclusion the Green Building Design into Green Supply Chain Management in order to minimize waste generation in the construction sector(Beldek et al., 2016).

H03: Green Supply Chain Management has no beneficial impact on development industry's waste management.

Ha3: Green Supply Chain Management has beneficial impact on development industry's waste management.

Brand/Corporate Image

The purpose of the research was to evaluate the effect of green supply chain administration methods on the brand image of India's construction projects. Green procurement processes get an immediate influence on organization image, as demonstrated by the study's findings. Based on these findings, the neuroscientist suggests that leaders and decision-makers implement sustainability practices which also facilitate the supplier to obtain numerous benefits(Benachio et al., 2019).

H04: Green Supply Chain Management does not enhance the Brand's reputation in the construction business.

Ha4: Green Supply Chain Management enhances the Brand's reputation in construction business.

7. RESEARCH METHODOLOGY

7.1. Research Design

Design/Methodology/Approach: That will examine peer assessments or subsequent papers published during the previous ten years about Application of GSCM methods within the construction industry.

The results of this study will be divided into four primary categories: supply chain links, competitive, life cycle, and waste management.

Scope of the study

This research used a thorough literature analysis and complies here to following requirements: (1) review conducted methodically or from a process; (2) provide a defined strategy. (3) be repeatable & updatable; and (4) summarize as well as synthesize the primary issue of the investigation. Through this strategy, it is feasible to establish systematic research that may provide the desired findings that can then be upgraded by other writers in the future for an examination of the subject's evolution through time.

7.2. Sampling

7.2.1. Sample Composition

Sample Composition for such proposed study would include professionals, academics, consultants, and manufacturers and distributors.

The strategy for sampling is detailed there in table below:

Table.7.1. Sampling Plan

Sl. No.	Sector	No of respondents
1	Academicians	07
2	Construction Industry	119
3	Green Building Certification Agencies	12
4	Design Consultant	10
5	Manufacturers	15
6	Distributors	20
	TOTAL	**183**

7.2.2. Sampling Technique

Simple Method of Random Sampling

7.2.3. Analysis and Interpretation

Regression, chi-square test, ANOVA, T-test using SPSS tool.

7.2.4. Sample Size Calculation

Using a statistics method to calculate sample size, the following qualitative factors must be taken into account:

a) Variation of standard deviation of demographic features (σ)

b) Level of confidence wanted or Z value (assumed to be 1.96 for a right level of 95% confidence)

c) Degree of accuracy sought in population characteristics estimation (D)

Researchers have explored the following equations for hypothesis testing around the mean: (Malhotra,2011). $n = \sigma 2\ Z2/D2$

Here, n = sample size σ = Standard deviation

Z = Standard normal variate for 95% confidence level and, D = Degree of precision desired

To order to achieve a realistic & representative sample size, we evaluated the sample size findings from three scenarios:

Scenario 1- Estimating a small standard deviation as well as a high degree of accuracy.

Scenario 2- A modest standard deviation & degree of accuracy are estimated.

Scenario 3- A large standard deviation and poor accuracy are estimated.

The results are summarized in Table.

Table 7.2. Comparative Analysis Taking Different Values of σ and D.

	Scenario 1	**Scenario 2**	**Scenario 3**
Σ	0.6	0.8	1
Z	1.96	1.96	1.96
D	0.1	0.12	0.12
N	138	160	250

Average = (n1+n2+n3)/3 (1)

= (138+160+250)/3

= 182.6 ≈ **183**

Overall total sample for our investigation is calculated to be 183 based on a weighted combination of all three scenarios involving varying values of and D.

7.2.5. Primary data collection

As understand that attitudes and intents of both the construction sector on the green supply chain and its influence on sustainability, surveys, sampling, questionnaires, testing, and analytic problems are used to do primary research. It also includes the industry's perspective on the desired outcomes and a cost-benefit analysis of a practice.

7.2.6. Secondary data collection

In relation to the dynamic character of both the research, secondary information will give relevant information and facts. Consequently, secondary data will be acquired first from following sources:

1) Journals

2) Research Reports

3) Reference Books

4) Relevant Magazines

5) Ministry of Environment, Forest and Climate Change

7.3. Method & Statistical Tools to be used

Table.7.3. Research Methodology

Stages	Research
Initial Review	That how GSCM idea may be used in our construction sector
Objective	Discover GSCM uses within the construction sector.
Criteria for considering Studies	Studies on the usage of GSCM techniques as in Construction Sector
Strategy to obtain thestudies	Explore diverse datasets for publications released during the last 10 years.
Eligibility	scholarly articles & proceedings
Data collection	Elimination of duplicate papers, then reviewing the abstracts, finally exclusion of duplicate articles. A thorough reading of the whole material.
Quality assessment	Authors' analyses of published works
Synthesize the results	A summary of all publications evaluated, organized by field of research

8. PROPOSE CHAPTERIZATION

Chapter 1: Introduction

Chapter 2: Review of literature

Chapter 3: Green Supply Chain Management & its impact on Construction Industry

Chapter 4: Research Design & Methodology

Chapter 5: Data Collection & Analysis

Chapter 6: Result & Discussion

Chapter 7: Conclusion

Chapter 8: Bibliography and References

Chapter 9: Appendix

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